An M939 5-ton medium truck sports a prototype armor protection kit for the vehicle's cab. In addition, contoured armor plates were installed under the hood, inside the dashboard, inside the floor of the cab and under the front wheel wells to protect the driver and gunner from small arms fire and explosive fragments from IEDs. (U.S. Army TARDEC photo.)

TARDEC Develops M939/M35 Crew Protection Kit Prototypes for *Operation Iraqi Freedom*

MAJ James A. Riddick

Responding to requirements from U.S. Central Command (CENTCOM) that truck drivers needed better protection against small arms fire and improvised explosive device (IED) fragments, Program Manager Tactical Vehicles (PM TV) COL Robert Groller contacted the U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC) in March 2004 to find a survivability solution. Soon after, prototype armor kits for the M939 and M35 series vehicles were under development.

Noting TARDEC's quick fielding of the Humvee Armor Survivability Kit (ASK), Groller requested that TARDEC develop prototype kits for testing and evaluation in a mere 90 days to reduce Soldier injuries and deaths in the CENTCOM area of operations. TARDEC was up to the challenge. Under the guidance of Deputy Director LTC Craig Langhauser, a matrix team was quickly organized for the project. To ensure customer requirements were met, PM TV representatives were an integral part of the team.

TARDEC engineers fitted the M939 up-armored cab with a Humvee lightweight gun ring. (U.S. Army TARDEC photo.)

Although PM TV did not authorize funding for the project until April 18, TARDEC's Emerging Technologies Team commenced armor design efforts on March 25. According to TARDEC Lead Project Manager Terry Avery, "This was, and continues to be, an all-out effort that has no margin for error. Every delay or mistake results in potential casualties to our troops. There's no greater motivation than to have the ability to provide equipment that saves lives."

PM TV declared that protection performance parameters must equal those for the Humvee ASK. Because there was a firm requirement for 2,229 M939-series kits but no firm number for the M35 system, priority was placed on developing the M939 prototype kit. At a start-of-work meeting, it was indicated that M939 A1 and A2 vehicles would need to be supported by this new armor protection kit.

M939 base vehicles would require upgrade to the A1 as part of the process, with front winches removed to accommodate the protection kit's anticipated weight. Information provided by PM TV indicated that there were 9 versions of the A1, A2 and M939 base vehicles with 27 possible variations. The kit would need to fit 18 of these variations. Field estimates indicated that approximately 40 percent of the vehicles in use in Southwest Asia were the M939 base variants and would need their winches removed.

TARDEC engineers first looked at an existing solution. In the early 1990s, 165 armor kits were developed for the M939 during operations in Bosnia, and they still existed in Army warehouses. This "Bosnia" crew protection kit would first need to be upgraded to provide enhanced side protection. By May 21, 2004, the TARDEC team had modified, fabricated, assembled and shipped two prototype kits to be tested at Aberdeen Test Center (ATC), which would determine the performance of these kits against *Operation Iraqi Freedom (OIF)* threats.

Unfortunately, the Bosnia kits did not meet the full *OIF* requirements. Testing was delayed while a new kit design and prototype was completed.

In addition to meeting threats, CENTCOM identified these operational requirements:

- Movable side windows for ventilation and firing of all infantry weapons.
- A gun ring that would permit mounting and firing of the M2 and M60 machine guns, M249 Squad Automatic Weapon and MK19 Grenade Machine Gun.
- A weapons platform.
- Digital rack.
- A cab air-conditioning (A/C) unit.

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There was great concern that the new requirements' additional weight would decrease the level of threat protection because the increased weight would need to be partially borne by the noncab vehicle structure. Additionally, movable windows would be a design challenge because the armored windows' estimated weight would be more than 100 pounds.

In an effort to optimize the material and reduce unnecessary weight, numerous armor material combinations were considered for various cab areas. Readily available armor materials and windshield transparency materials were given highest priority because this approach would lead to lowest schedule and cost risk over the project's life cycle.

To meet the most important requirement — crew protection — TARDEC engineers developed and manufactured a new cab that consisted of armored cab walls and doors, which included the applied armored glass, powered actuators to assist in moving the heavy doors and a powered protected door assembly that can move the side transparencies up and down for ventilation and firing purposes. To be able to mount the required weapon platforms, engineers fitted the armored cab's roof with the Humvee lightweight gun ring. To add a bit of comfort and to make room for the A/C and gunner platform, two new air ride seats were installed. The kit fits the M939 basic, A1 and A2 series vehicles.

Bench seats were removed and new air ride bucket seats were installed to accommodate the gunner platform and A/C unit. In addition, power actuators were installed to assist in moving the heavy doors along with a powered assembly that moves the side transparencies up and down.
(U.S. Army TARDEC photo.)

For even more protection, TARDEC technicians added contoured armor plates under the M939 hood and inside the dashboard to reduce the threat of small arms fire through the hood region. Armor plate was also mounted inside the floor of the cab as well as under the front wheel wells to reduce the threat of fragments from IEDs.

To meet the A/C requirement, TARDEC collaborated with the Red Dot Corp. of Seattle, WA, to modify an existing Humvee A/C kit to fit into the M939 — commonality between vehicle systems would simplify parts supply and repair procedures. The cab's interior was redesigned to accommodate the A/C system. To make room for the evaporator cooler fan console, the bench seat and battery box were removed and relocated. The console was then mounted between the two new bucket seats; a new gunner's platform was mounted on the console's top. Within 2 weeks of inception, a functional A/C system was installed.

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Armor kit assembly and installation and A/C was completed by June 21. The next day, the first two kits were sent to ATC for automotive and safety testing, with one kit to become the "ballistic turret and hull" for live-fire testing against the standardized *OIF* threats.

This intense effort is indicative of what TARDEC engineers can accomplish to provide rapid support to combatant commanders and their Soldiers in the field. This kit provides the highest level of protection of any of the tactical vehicle armor kits that have been tested thus far. It's been gratifying to receive positive feedback from the troops using U.S. Army Research Laboratory/TARDEC/ Ground Systems Industrial Enterprise-produced equipment. Our goal is to continue to provide our Soldiers with improved lethality, survivability and sustainability.

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